Modeling the Cloud

Methodology for Cloud Computing Strategy and Design

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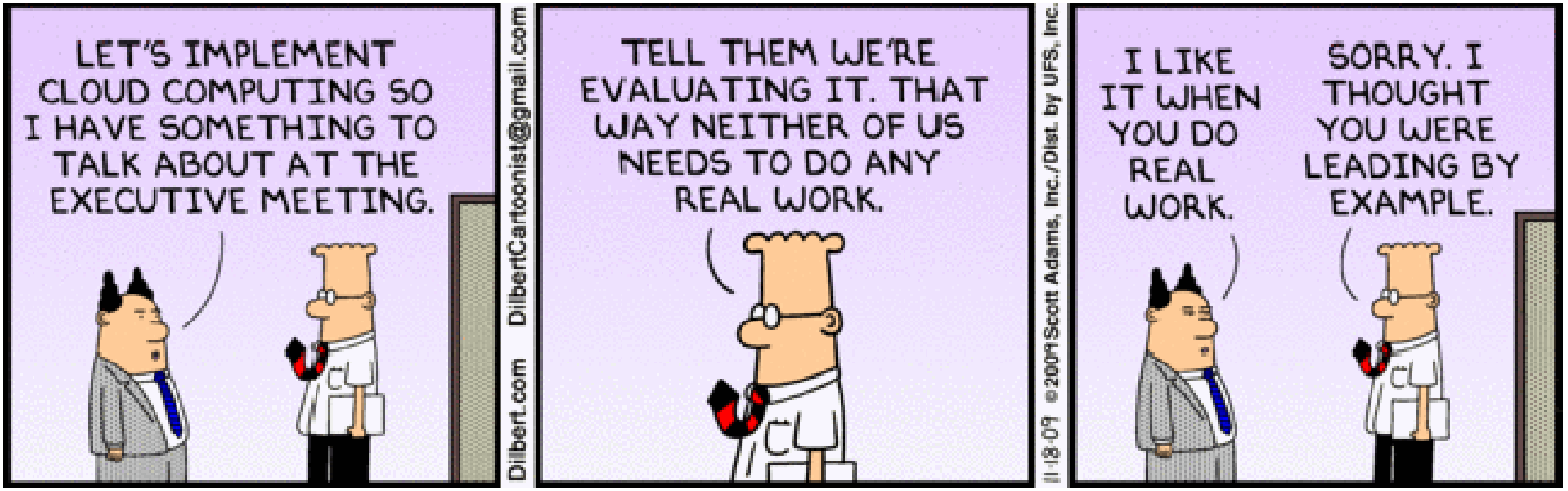
Introduction

Dilbert's Cloud Philosophy

(c 2009 Scott Adams)



Demystifying cloud, what cloud is and is not...

Cloud is…

…on-demand	Clouds can provide an almost immediate **access to a pool of hardware resources** (compute, network and storage) that can be **allocated and provisioned** on-demand
…scalable and elastic	The key characteristic of a cloud service is the ability to **dynamically provision and de-provision** compute, memory, and storage resources, and to be able to **seamlessly scale services (up or down)** to meet client needs
…pay-as-you-use	Vendor-provided cloud solutions do not require upfront capital investments by the buyer. **Billing is tied to metered use** of resources, shifting expenses from CapEx to **OpEx.** Internally or externally hosted private clouds do require CapEx, but have the potential to reduce both CapEx and OpEx

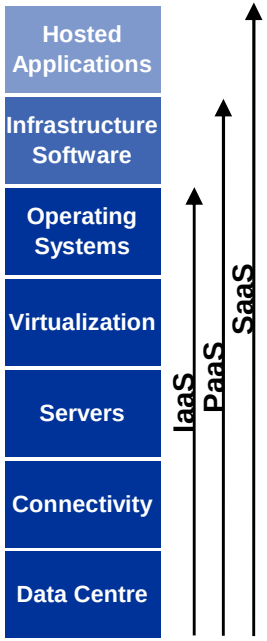
Cloud is not…

…simply virtualization	While many **cloud solutions**, both public and private, **leverage virtualized infrastructure resources** to deliver functionality, cloud raises the bar by providing on-demand provisioning. Publicly-announced private clouds are essentially an aggressive virtualization program on top of the traditional enterprise IT stack
…just applying SOA principles	**Service Oriented Architecture (SOA)** is a set of **design principles**, whereas **cloud is a service**. Cloud based services will be **defined and enabled through SOA**. As such SOA is a prerequisite to reap cloud computing benefits. However, following SOA design principles alone does not guarantee the ability to easily transition to a cloud based solution
…traditional hosting	**Cloud and traditional hosting** share many characteristics but unlike traditional hosting cloud service is offered **on-demand, is scalable and elastic** – a user can have as much or as little of the service as they need and pay for the resources actually used

Cloud computing offers **increased agility** through **faster time to market, lower upfront IT capital expenditure and the ability to easily scale up / down and reallocate resources**. However, technical, operational and financial hurdles need to be overcome before cloud can be used extensively by large enterprises

Cloud services offer multi-tenant, on-demand, scalable, elastic, pay-as-you-go building blocks to deploy IT solutions

Cloud Service Types



Service Type	Definition	Cloud Candidates	Sample Vendors
Software-as-a-Service (SaaS)	Provider licenses an application to customers for use as a service on demand	▪ Non-core applications (e.g., HR, CRM, and document collaboration) ▪ Email	salesforce.com, Gmail, Google, ORACLE ON DEMAND, RIGHT NOW
Platform-as-a-Service (PaaS)	Building, delivering applications & services from Web; Computing platform and solution stack as a service	▪ Large-volume storage, batch processing, large-volume computations ▪ VoIP, Virtualized Desktops, Cloud Storage	Windows Azure, vmforce ...is coming!, force.com platform as a service, Google App Engine
Infrastructure-as-a-Service (IaaS)	Computer infrastructure (typically a platform virtualization environment) as a service	▪ Dev and Test Environments ▪ High compute calculations (e.g., Monte-Carlo scenario analysis) ▪ Web servers	amazon web services, terremark, hp, IBM, rackspace

Cloud Delivery Models

Delivery Model	Definition	
Public Cloud	▪ External to a client's premises ▪ Infrastructure third-party owned and managed ▪ Multi-tenant	▪ Subscription-based ▪ Scalable and elastic ▪ Metered by use ▪ Access via Internet
Virtual Private Cloud	▪ External to a client's premise ▪ Third-party owned and managed ▪ Multi-tenant (but virtually private)	▪ Scalable and elastic ▪ Access via dedicated but private link to public cloud ▪ Segmented, secured, or compartmentalized for client
Private Cloud	▪ Usually internal and delivered on client premises (although can be hosted by third-party provider) ▪ Only used by internal customers	▪ Scalable but with elasticity constraints ▪ Access via private link or internal ▪ Exclusive membership ▪ Spectrum of control / ownership
Community Cloud	▪ As per private cloud but shared infrastructure resources with "communities" or groups with similar requirements (e.g., industry peers)	
Hybrid Cloud	▪ Mix of private and public cloud environments (e.g., data stored in private premises but other infrastructure shared in public cloud)	

Where does cloud fit? (Source: David Linthicum c 2010)

A Fit When:	Not A Fit When:
Processes, applications, and data are largely independent	Processes, applications, and data are largely coupled
Points of integration are well defined	Points of integration are not well defined
Lower level of security is fine	Higher level of security is required
Core internal enterprise architecture is healthy	Core internal enterprise architecture needs work
Web is the desired platform	The application requires a native interface
Cost is an issue	Cost is an issue
Applications are new	Application is legacy

Where to Begin

Where to Begin? Technology Strategy

1. Begin with a review of the business strategy, realized through a business operating model

2. Define the business drivers, scope and key stakeholders, data, services and processes

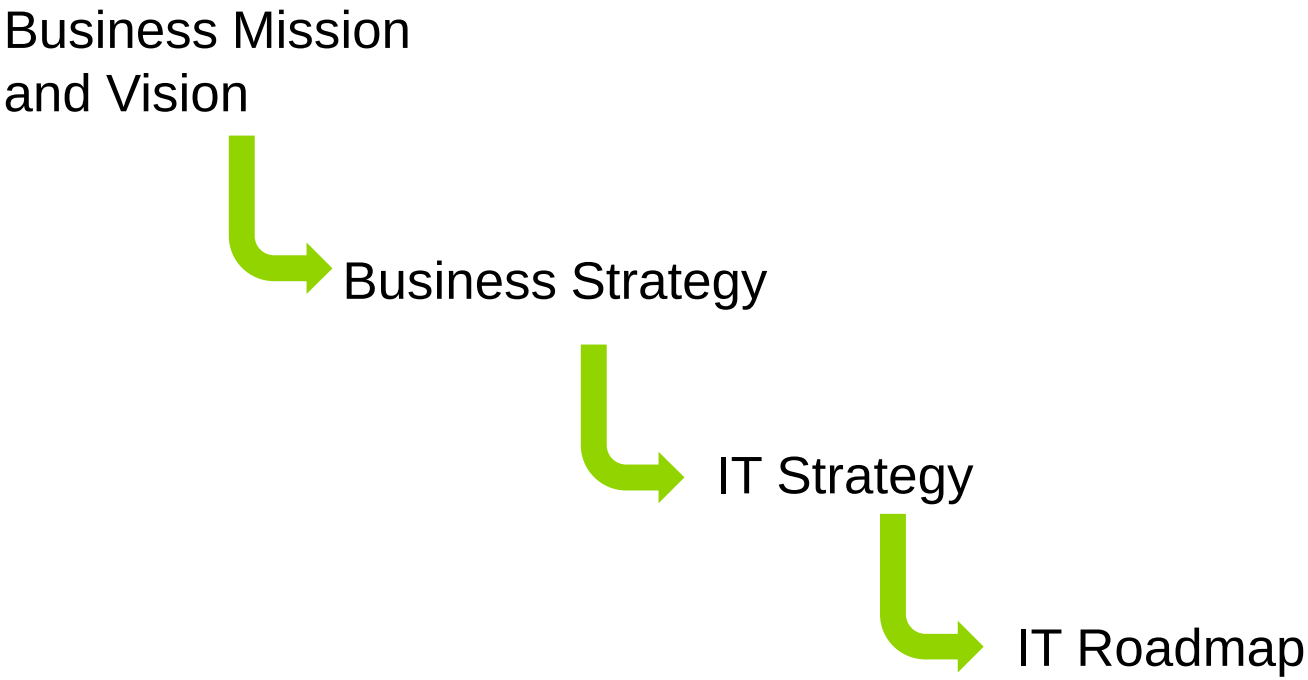
3. Assess the current state, define the future state, and create a transition plan “roadmap”

4. Leverage an enterprise architecture methodology, such as TOGAF and/or DODAF, to build integrated artifacts

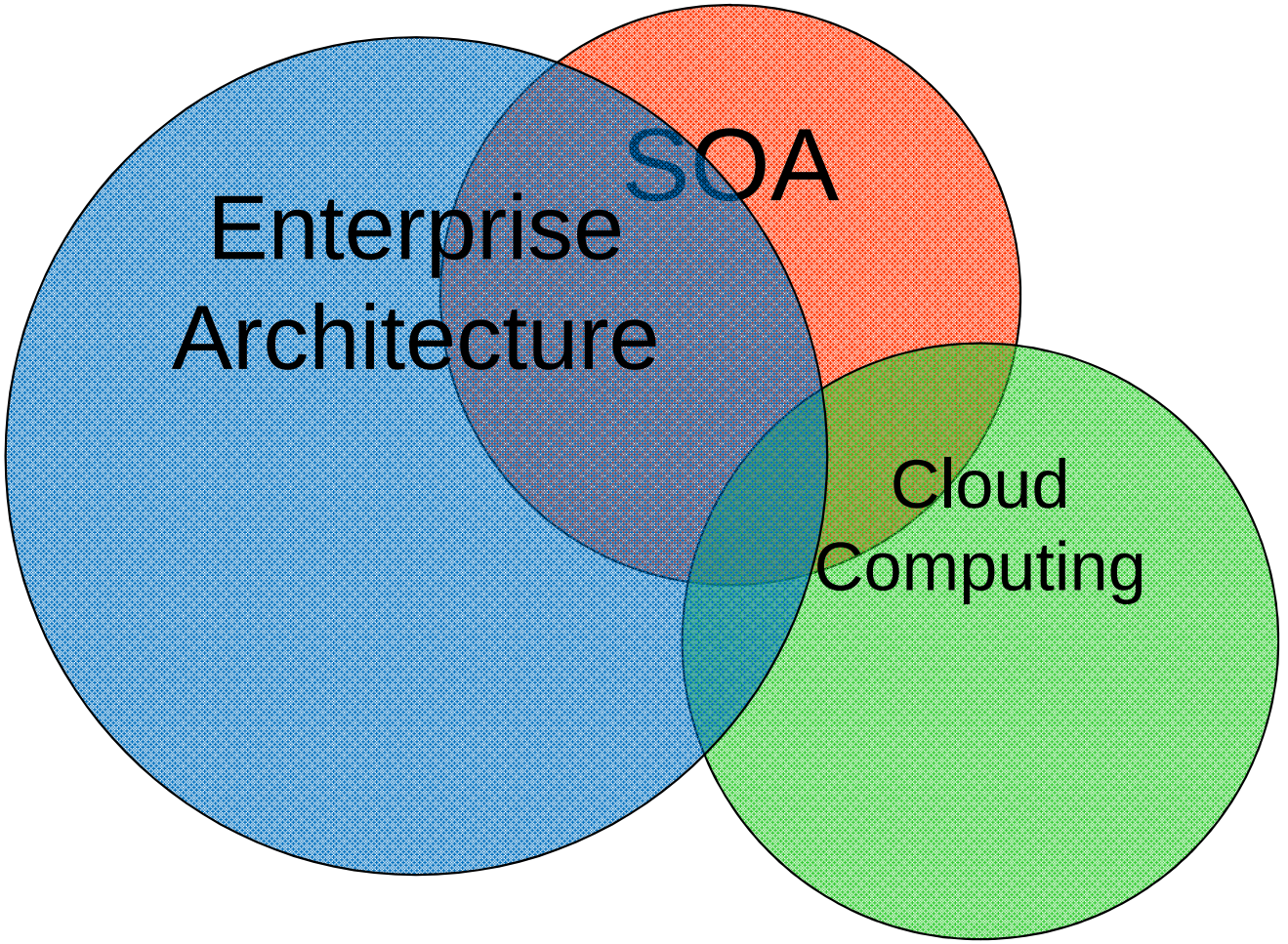
5. Extend the business and technology analysis to define parameters and metrics to apply to all technology alternatives, including cloud

6. Incorporate all findings to prioritize a technology migration plan

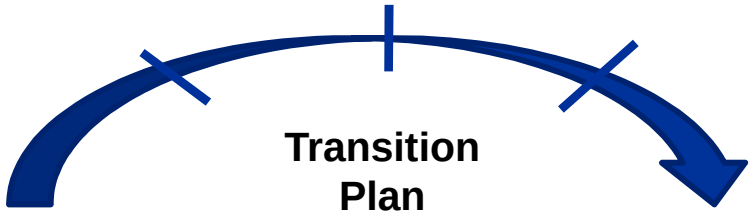
Strategy Relationships



Understanding the Relationships (Source: David Linthicum c 2010)



Simplified View of Enterprise Architecture



Mission & Vision

Environmental Changes

	Current State	Future State
Business	• Stakeholders • Capabilities • Services • Processes • Logical Data	• Stakeholders • Capabilities • Services • Processes • Logical Data

Technology	• System Actors
	  • Existing Systems
	  • Manual Systems
	• System Functions
	• Physical Data
		• Technology Options
		1._____
		2._____
		3._____ …

Standards and Reference Models

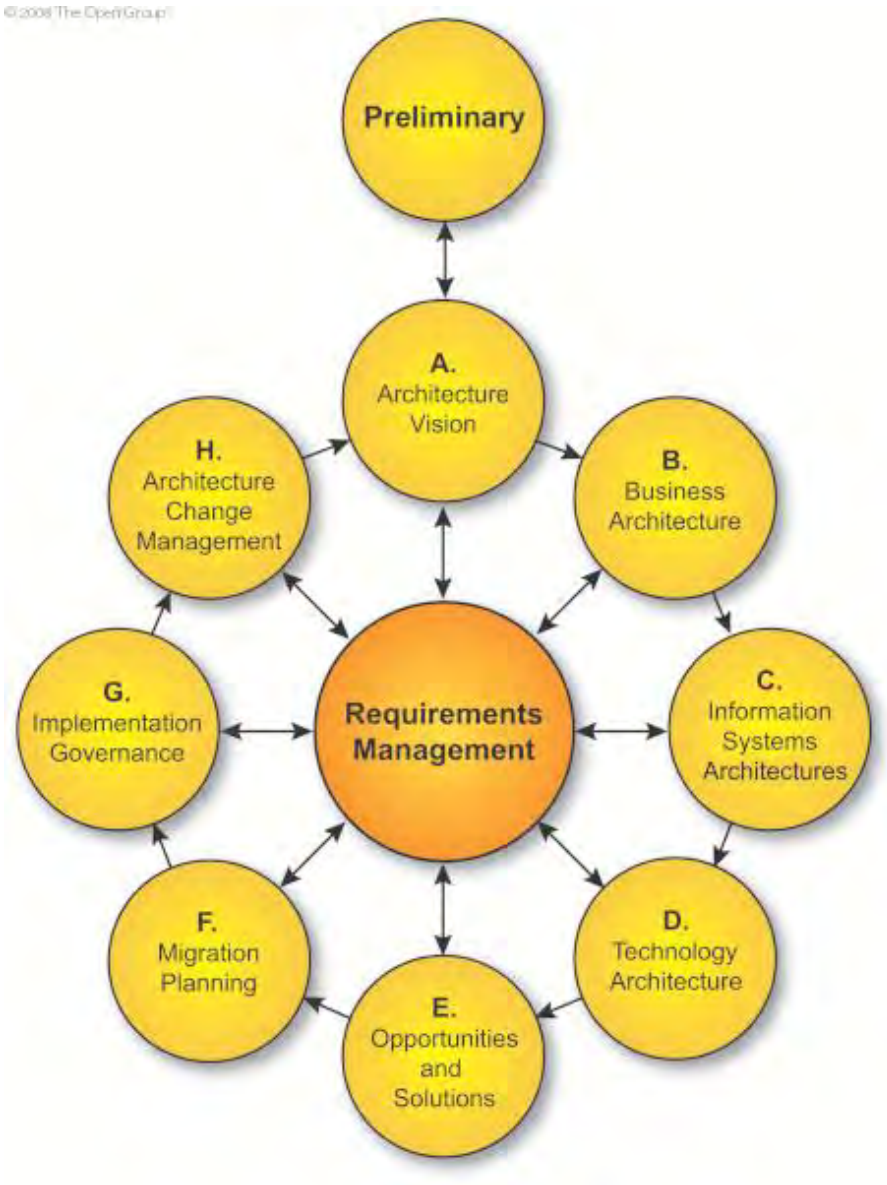
Leverage the Business Operating Model Classification

Cited from “Enterprise Architecture as Strategy” c 2006 HBS Press

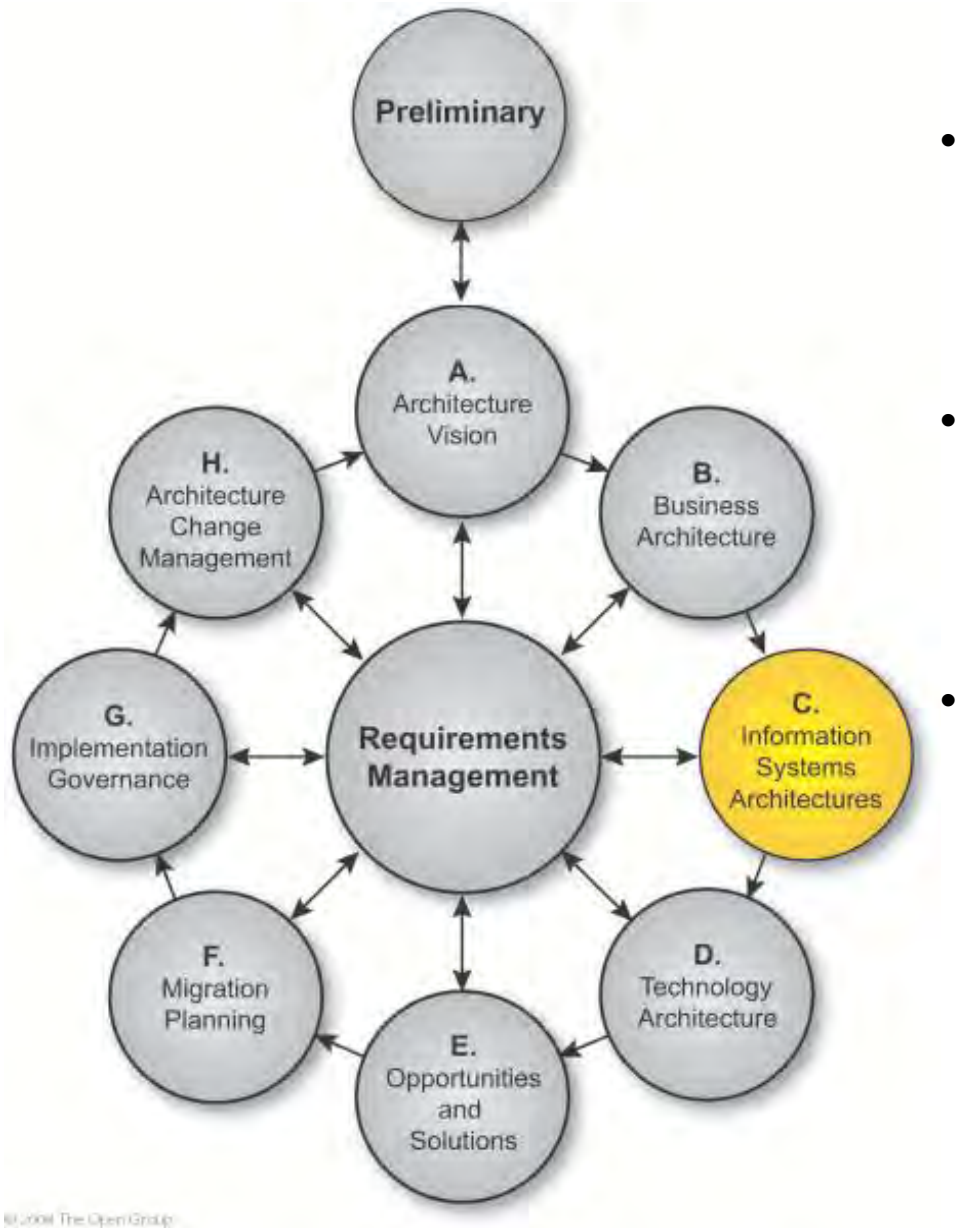
Scoping

- There are four dimensions in which scope may be defined and limited:
  - Enterprise scope or focus
  - Architecture domains
  - Vertical scope (level of detail)
  - Time periods (project schedule)

The Open Group Architecture Framework (c The Open Group)



Phase C: Information System Architecture (c The Open Group)



- Defines the applications and data considerations that support the enterprise's Business Architecture
- Primary outputs of the ISA are Target Architectures covering data and/or application system domains
- Consider:
  - Data → Service → Process → Platform
  - Define the information models
  - Define the service models
  - Cloud obscures platform details

Why Information System Architecture Matters to the Business, for Cloud

- **Data Architecture** – defines the major types and sources of data necessary to support the business in a way that is understandable by stakeholders, complete and consistent, and stable
  - Not database design, it's about defining data elements and data relationship rules relevant to the enterprise.

- **Application Architecture** – defines the major kinds of application systems necessary to process data and support the business.
  - Not application systems design, it's what applications are relevant to the enterprise.

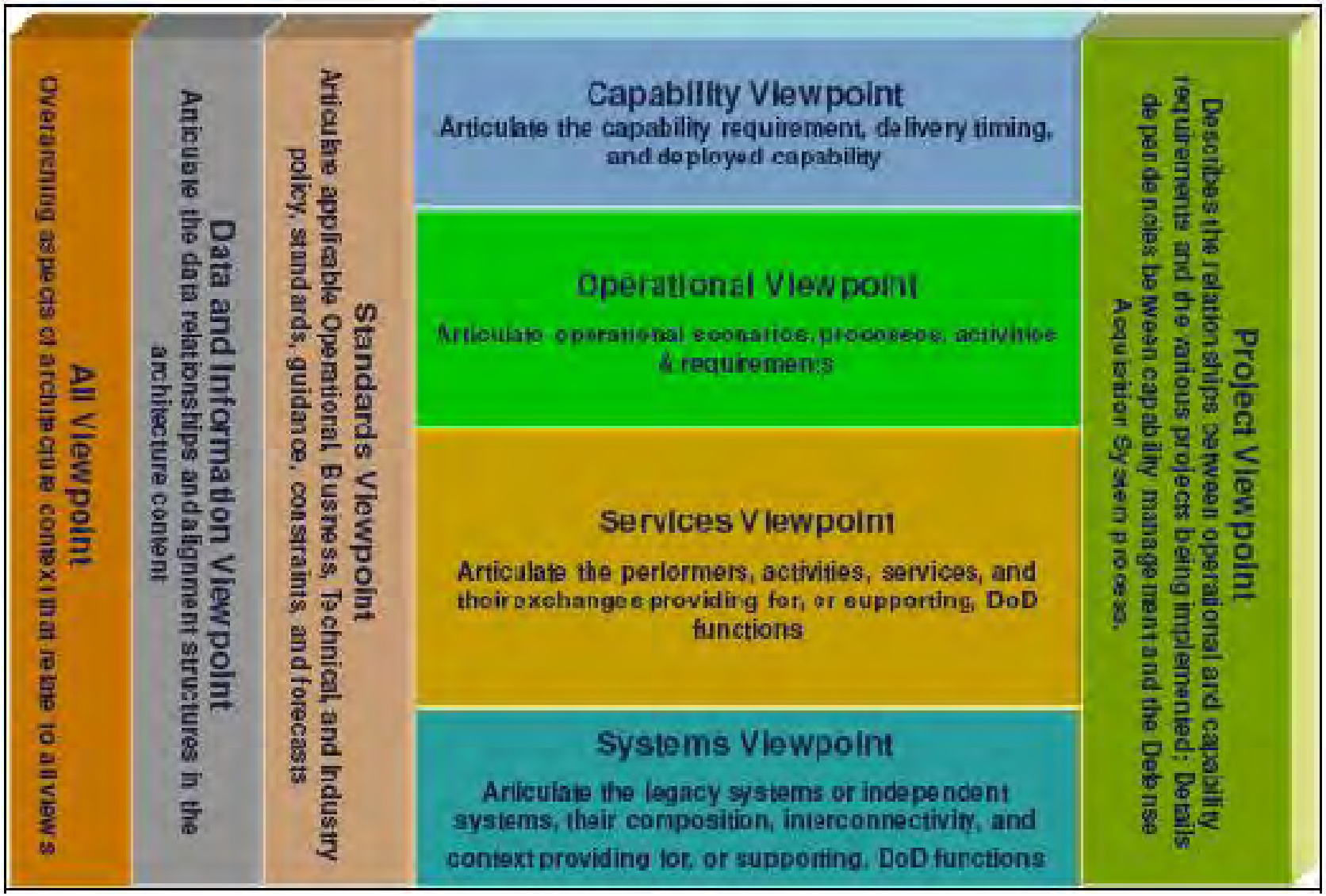
Artifacts List - Data Architecture

- Data Entity/Data Component catalog
- Data Entity/Business Function matrix
- System/Data matrix
- Class Diagram or Relational Data Model
- Data Dissemination diagram
- Data Security diagram
- Class Hierarchy diagram
- Data Migration diagram
- Data Lifecycle diagram

Artifacts List – Application Architecture

- Interface catalog
- System/Organization matrix
- Role/System matrix
- System/Function matrix
- Application Interaction matrix
- Application Communication diagram
- Application and User Location diagram
- System Use-Case diagram
- Enterprise Manageability diagram
- Process/System Realization diagram
- Software Engineering diagram
- Application Migration diagram
- Software Distribution diagram

The DoD Architecture Framework (DoDAF) Viewpoints



Operational Viewpoint (OV)

- Organizations and Performers (actors/stakeholders)
- Tasks, or activities performed (processes)
- Information that must be exchanged between tasks/activities for mission accomplishment (data)
- Types of information exchanged
- Frequency of exchange
- Which tasks and activities are supported by the information exchanges, and
- Nature of information exchanges.

Operational View Models

OV-1: High Level Operational Concept Graphic	The high-level graphical/textual description of the operational concept.
OV-2: Operational Resource Flow Description	A description of the resource flows exchanged between operational activities.
OV-3: Operational Resource Flow Matrix	A description of the resources exchanged and the relevant attributes of the exchanges.
OV-4: Organizational Relationships Chart	The organizational context, role or other relationships among organizations.
OV-5a: Operational Activity Decomposition Tree	The capabilities and activities (operational activities) organized in an hierarchal structure.
OV-5b: Operational Activity Model	The context of capabilities and activities (operational activities) and their relationships among activities, inputs, and outputs; Additional data can show cost, performers or other pertinent information.
OV-6a: Operational Rules Model	One of three models used to describe activity (operational activity). It identifies business rules that constrain operations.
OV-6b: State Transition Description	One of three models used to describe operational activity (activity). It identifies business process (activity) responses to events (usually, very short activities).
OV-6c: Event-Trace Description	One of three models used to describe operational activity (activity). It traces actions in a scenario or sequence of events.

Services Viewpoint (SvcV)

- System Functionality
- Service Functionality
- Interconnection between Services
- Service support for Operational Activity

Services Viewpoint Models

SvcV-1 Services Context Description	The identification of services, service items, and their interconnections.
SvcV-2 Services Resource Flow Description	A description of resource flows exchanged between services.
SvcV-3a Systems-Services Matrix	The relationships among or between systems and services in a given Architectural Description.
SvcV-3b Services-Services Matrix	The relationships among services in a given Architectural Description. It can be designed to show relationships of interest, (e.g., service-type interfaces, planned vs. existing interfaces).
SvcV-4 Services Functionality Description	The functions performed by services and the service data flows among service functions (activities)
SvcV-5 Operational Activity to Services Traceability Matrix	A mapping of services (activities) back to operational activities (activities).
SvcV-6 Services Resource Flow Matrix	It provides details of service resource flow elements being exchanged between services and the attributes of that exchange.
SvcV-7 Services Measures Matrix	The measures (metrics) of Services Model elements for the appropriate time frame(s).
SvcV-8 Services Evolution Description	The planned incremental steps toward migrating a suite of services to a more efficient suite or toward evolving current services to a future implementation.

Services Viewpoint Models (continued)

SvcV-9 Services Technology & Skills Forecast	The emerging technologies, software/hardware products, and skills that are expected to be available in a given set of time frames and that will affect future service development.
SvcV-10a Services Rules Model	One of three models used to describe service functionality. It identifies constraints that are imposed on systems functionality due to some aspect of system design or implementation.
SvcV-10b Services State Transition Description	One of three models used to describe service functionality. It identifies responses of services to events.
SvcV-10c Services Event-Trace Description	One of three models used to describe service functionality. It identifies service-specific refinements of critical sequences of events described in the Operational Viewpoint.

Integrating Artifacts

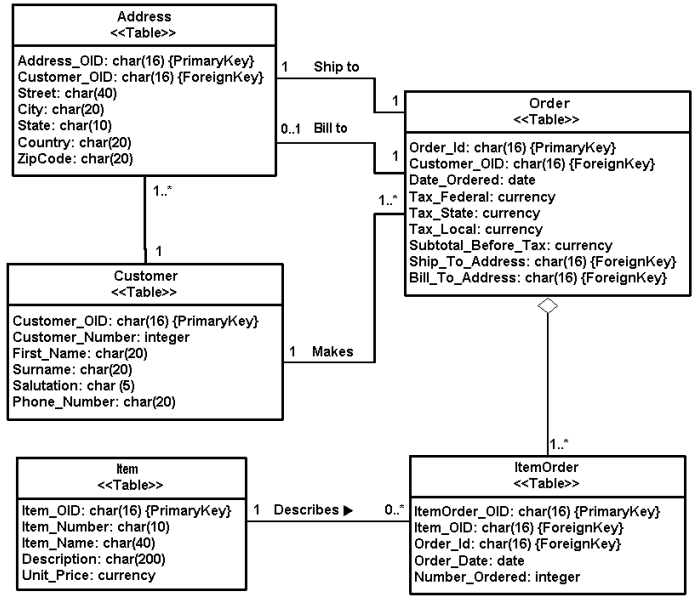
- Data and Applications artifacts should have the same scope to support the analysis and documentation
- Cross-referencing the artifact components in a matrix can identify where and how specific data objects support specific application functions
- Repository-based EA tools can store data objects for use in associating with processes when building process models
- Associations between logical data and logical business processes are frequently stable over time

Leverage Artifacts to Populate the Enterprise Architecture

1. Artifacts range from catalogs, to matrices to diagrams to models
2. Sample business artifacts include stakeholder interaction diagrams, process models and data models
3. Sample technology artifacts include system catalogs, physical data models
4. Sample transition artifacts include consolidated gaps, solutions and dependencies assessment matrix, architecture definition increments table, business/benefit value assessment matrix
5. Define services at the macro and micro business and technology levels, and define parameters (as if to outsource)

Example: Logical Data Model and Business Object CRUD Matrix

- Integration and optimization of business processes and systems functions requires understanding the data elements supporting the activities
- Data Models are the most stable products in architectures. Data entities, attributes, and their relationships reflect, analyze and enforce business rules in the most logically consistent way
- Conceptual, Logical and Physical Data Models are leveraged across multiple layers of the architecture framework
- Including data sets in system artifacts adds valuable detail and strengthens links across business, solution and systems architectures



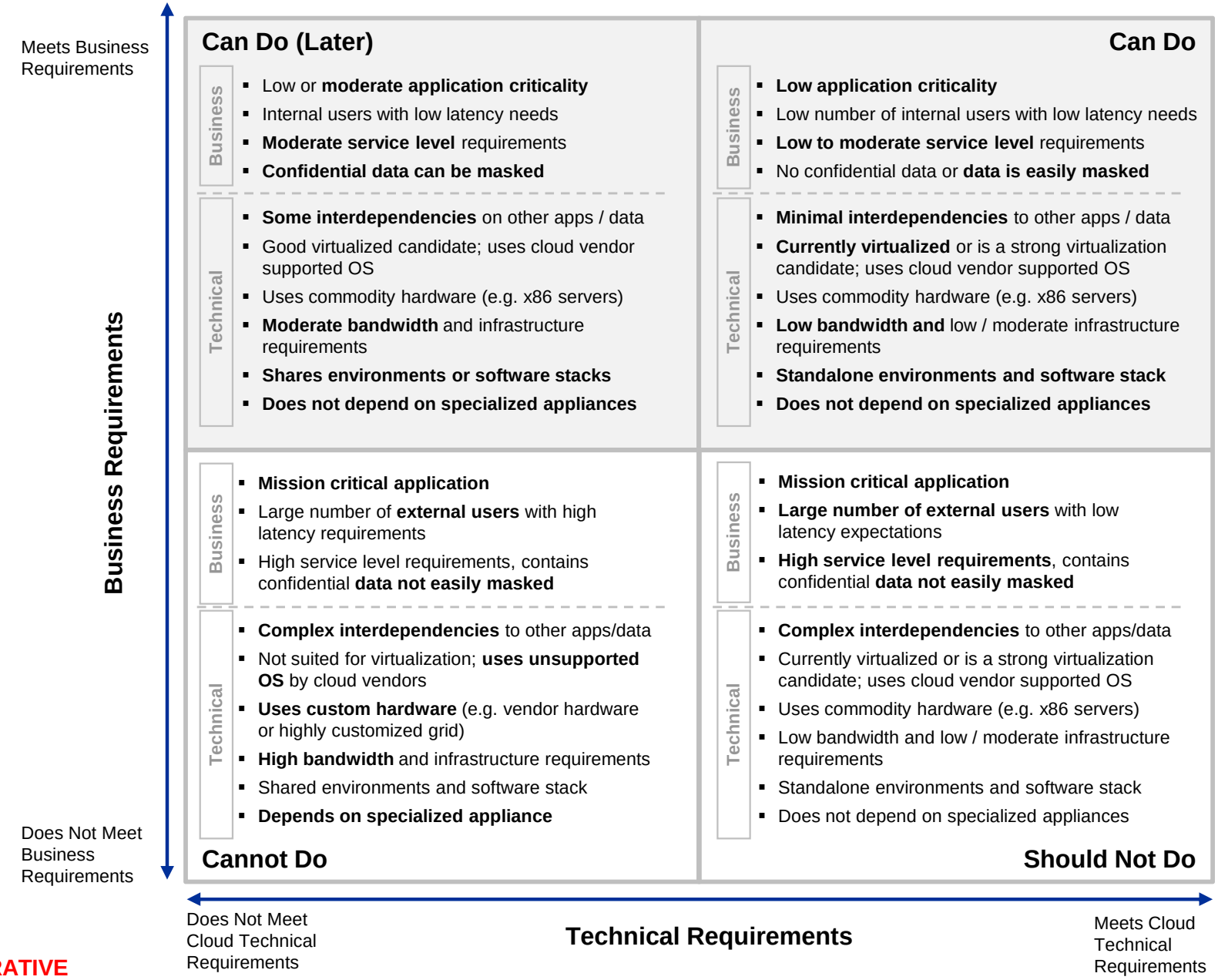
In the diagrams to the right:

- The data model excerpt identifies data entities, attributes and relationships, and
- The Business Object CRUD Matrix maps primary functions with data entities, detailing where a function “Creates”, “Reads”, “Updates” and/or “Deletes” instances of the data. This is a critical cross reference between data and functions.

Order Processing System CRUD Diagram 2

	Customer	Customer Order	Customer Account	Customer Invoice	Vendor Invoice	Product
Maintain Customer Order	U		U		RU	
Terminate Customer Order	U		U		RU	
Receive Customer Order	R	C	CR			
Process Customer Order	CRU		RU			R
Fill Customer Order	RU		RU			RU
Invoice Customer	RU		RU	C		
Ship Customer Order			U		C	
Validate Vendor Invoice					R	
Pay Vendor Invoice					RU	
Maintain Inventory						CRUD

IaaS cloud suitable applications should be evaluated based on the degree of technical and business fit against key cloud characteristics



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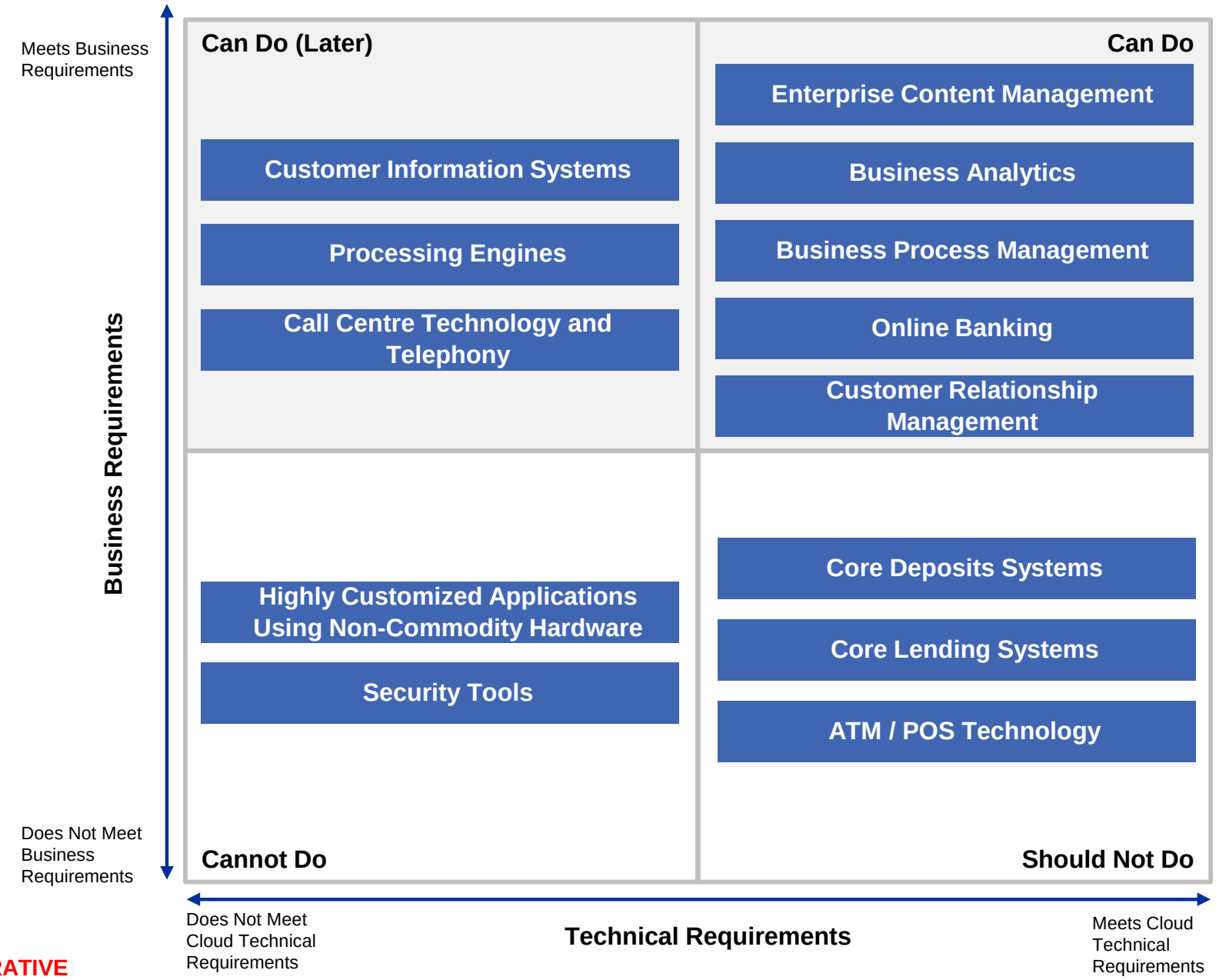
Common initial cloud candidates include Analytics, ECM, and BPM tools



ILLUSTRATIVE

Current State Analysis

Simplified View of Enterprise Architecture

Mission & Vision

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		2. _____
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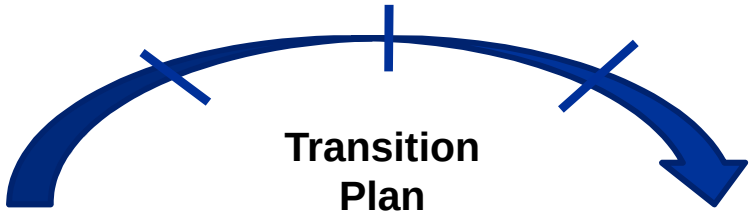
Standards and Reference Models

Future State Analysis

Simplified View of Enterprise Architecture



Mission & Vision

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Standards and Reference Models

Analysis of Future State

Business and IT Strategy Alignment	▸ How do cloud computing technologies and services align with business and IT strategic goals? ▸ What business benefits can be derived by utilizing cloud computing technologies, and to what degree?
Opportunities	▸ How can you determine which, if any, cloud computing technologies and services are suitable for the company? ▸ How does cloud technology differ with existing service types, in terms of functions and characteristics? ▸ How can cloud technology support current and new service or application deployments? ▸ Which cloud computing services provide the highest potential business value? ▸ How much flexibility in Capital / Operating Expenditures can be gained?
Technologies and Services	▸ Which cloud computing technology fit your current or planned IT infrastructure and architecture? ▸ Which cloud computing vendors fit your IT and business needs?
Delivery Models	▸ To what degree can the existing delivery methods be leveraged? ▸ Who are the leading cloud computing providers for each service type and technology? ▸ How will procuring cloud services affect relationships with existing vendors? ▸ Are the standard Service Level Agreements acceptable to you?
IT Readiness	▸ What business and IT processes are affected when transitioning to cloud-based capability? ▸ To what degree can existing IT infrastructure, technologies, and services be leveraged? ▸ Does the organization have the capabilities to make adequate use of cloud computing technology? ▸ Are the appropriate security and privacy controls in place to support cloud computing technology?
Roadmap	▸ What are the immediate next steps? ▸ What cloud computing initiatives can be planned to take place in the next 2-3 years?

Additional Considerations for Future State Technology

Define metrics for critical business performance areas, and ensure these are inherited by system alternatives

Include cloud computing options as part of the future state technology alternatives for comparison

Ensure systems principles of technology architecture, dependability, and performance metrics are maintained through all alternatives, which often will require levels of diversification and redundancy to achieve

Ensure service definition and metrics are derived from the business operating model

Ensure the technology alternatives support and map to the business drivers, scope, stakeholders and operating model

Not all applications are suitable for cloud, enterprises should consider several dimensions when evaluating which future applications are built to be cloud-ready

Considerations For Building a Cloud Ready Application

Technology

- Do the workloads exhibit characteristics that can **derive real benefits from scalability and elasticity?**
- Will the application be built to run on a cloud supported platform (e.g., commodity hardware, supported OS)
- Can the **application components be architecturally designed to be suitable for deployment to a cloud** based solution?
- **What design trade-offs will be needed** to make this application cloud-ready?
- Are internal IT architecture and organization structures “ready”?

Business

- What are the anticipated usage patterns for the application and will it be cost effective to move to the cloud?
- What is business sponsor's **preference for CapEx vs OpEx?**
- How will designing for cloud readiness **impact my implementation cost and timelines?** Can I achieve overall **lower TCO**?
- **Will moving to cloud help me capture new sources of value** for the business?
- **Are cloud offerings mature enough** for these workloads?

Operational

- **What are the availability requirements** for this application and can those be met by cloud?
- **How will support model for this application change** if it is moved to the cloud? Are the potential changes acceptable?
- How will cloud **impact my chargeback model** for this application? **Can I support the new model?** Will business accept the changes?
- Can cloud meet my business continuity and disaster recovery requirements for the application?
- Is the vendor limiting interoperability or access to your data?

Regulatory and Compliance

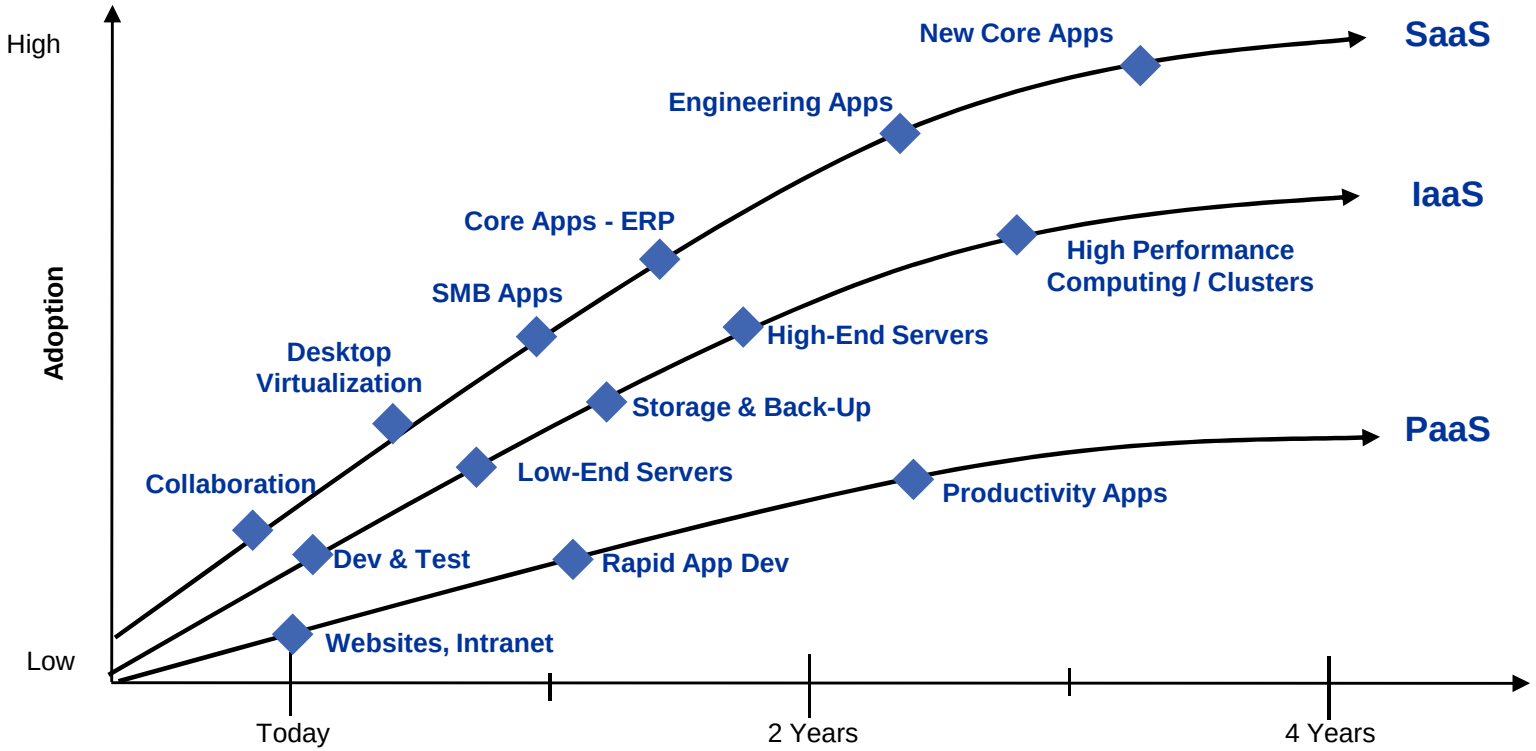
- Are there any **risk management or compliance requirements for this application**? Will cloud be able to satisfy those requirements? (e.g., Audits)
- Does the application hold confidential or customer data? Can this **data be easily masked in the future?**
- Does the application data need to reside within organization? Will we be **prohibited from moving data outside of the country**?
- Who owns the data? How is it be used? Are controls in place?
- How is security achieved? What is the level of privacy protection?
- Can you meet needs for legal compliance and tax issues?

Applications most suited to cloud computing have dynamic and unpredictable usage patterns, compared to more static hosting environments

Comparing Managed Hosting to Cloud Computing

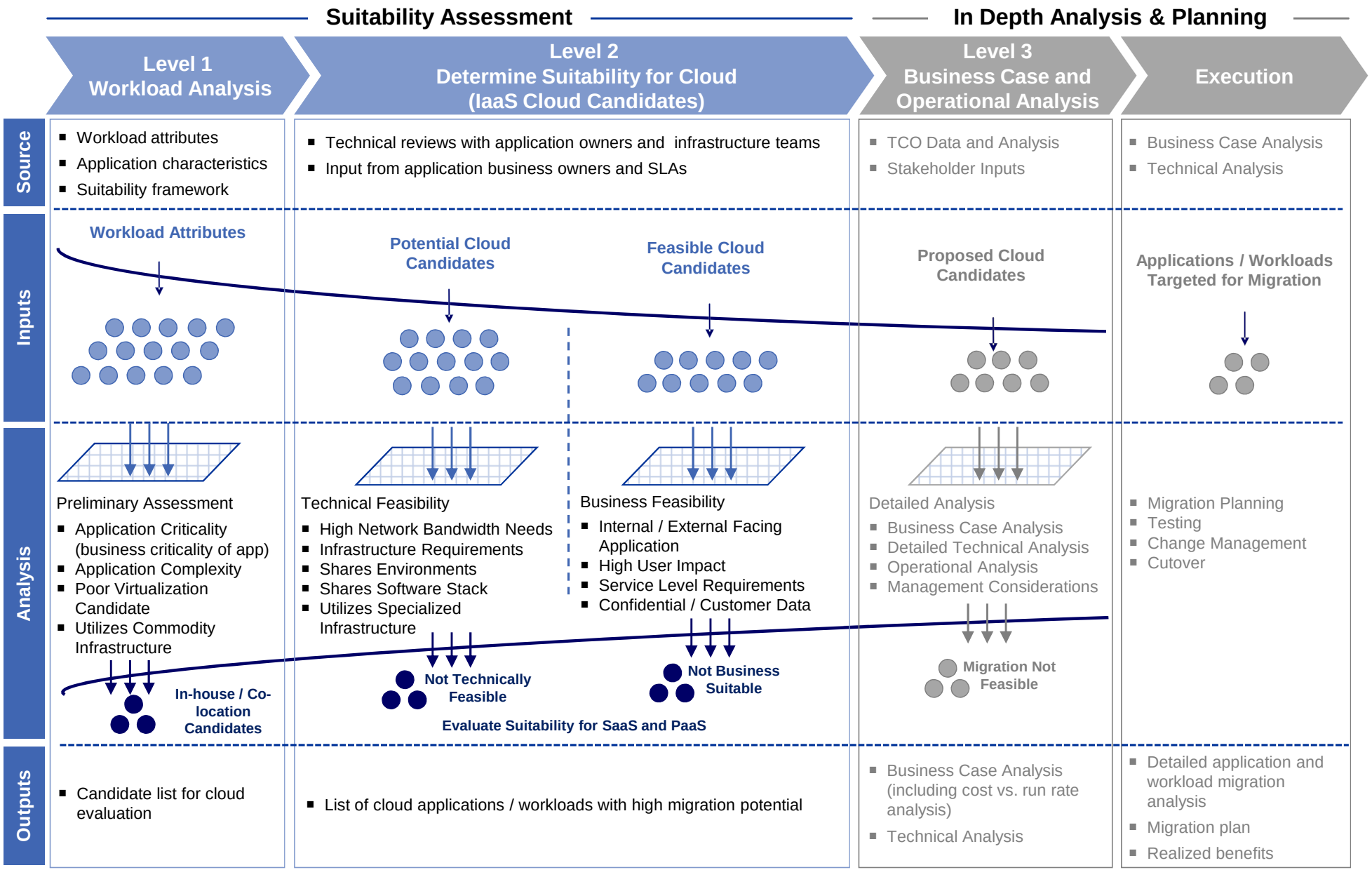
Managed Hosting Applications	▪ Email & Messaging ▪ Voice Systems ▪ Corporate Web Sites ▪ Back-Office Systems	▪ Legacy Applications ▪ Structured Databases ▪ Financial Systems	**"Static & Continuous"**
Cloud Applications	▪ Software as a Service ▪ Dynamic Applications ▪ High-Compute Processing	▪ Collaboration & Analytics ▪ Test and Development ▪ DR, Backup and Storage	**"Dynamic & Bursty"**

Mainstream Adoption of Workloads by Service Type



Service type solution maturity over the next 4 years and expected timeframe for mainstream adoption of workload types

A structured approach should be taken when reviewing IaaS cloud suitability factors for applications and workloads



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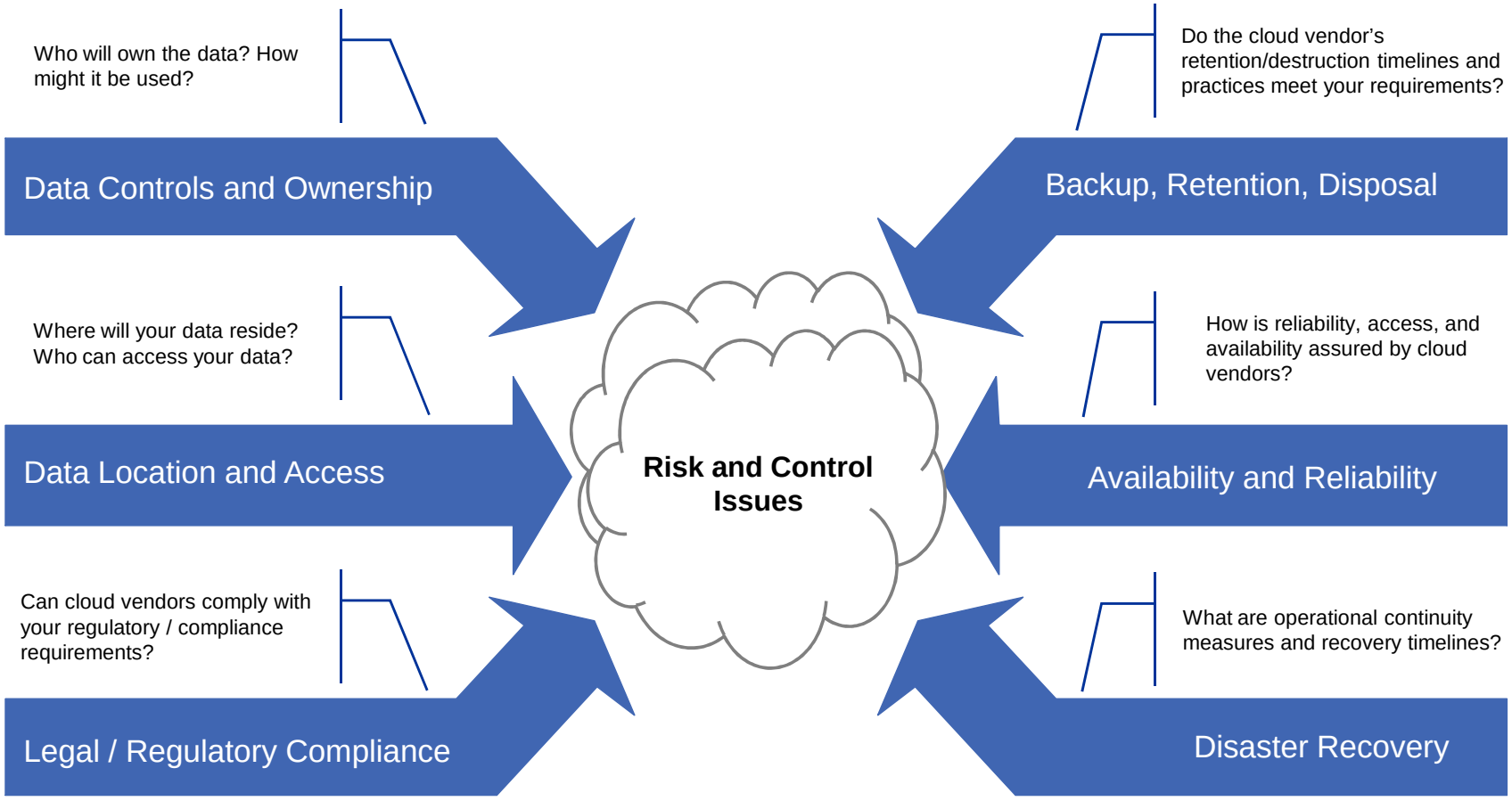
Organizations face a wide range of new risk and control considerations when transitioning to the cloud

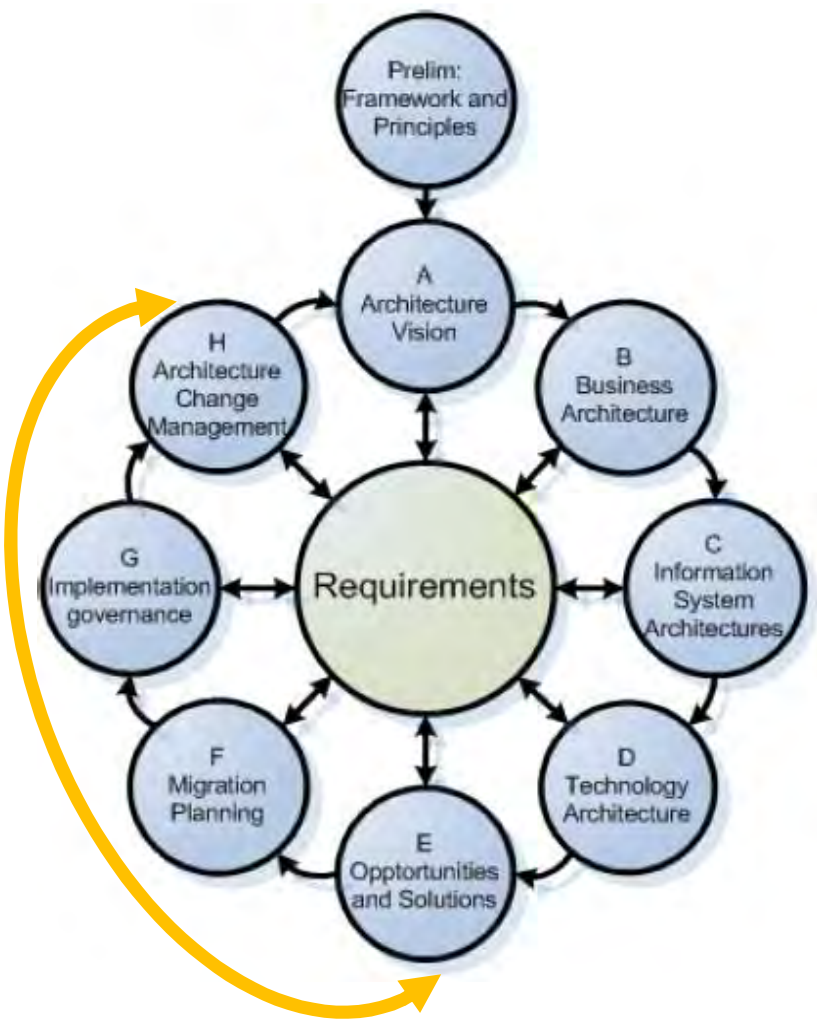
- Amongst the many operational impacts cloud brings, it introduces new inherent risks and increases the complexity of managing existing risks that may be well controlled in the internal environment; primarily around data security.
- For instance, a non-US company may face the challenge of a vendor only providing data centres in the US which would make data subject to the Patriot Act.

Risk and Control Considerations



Transition Planning

Transition Planning: Leveraging TOGAF Phases E, F, G &H:



- **Opportunities and Solutions:**
- Identifies changes and projects to be undertaken to move from current to target state.
- **Migration Planning:**
- Focuses on prioritization of projects. Generates detailed implementation roadmap, timeline as well as the impact analysis.
- **Implementation Governance:**
- Defines implementation contract which guides and governs the projects.
- **Architecture Change Management:**
- Helps to manage changes in a cohesive way.

Transition Planning

The most critical aspect of transition planning: the evolution of the business operating model

Leverage the gap analysis between current state business and future state business, between current state business and current state technology, and between current state environmental factors and future state projected environmental conditions

Ensure performance metrics are defined and baselined for realistic comparison of alternatives and for prioritization of migration options

Transition Planning Includes Data Security

Example of Systems Security Concerns, cited from the US Federal Cloud Computing Strategy

(Detailed cloud security guidance is available through a series of NIST publications. NIST has also classified cloud service models and cloud deployment models.)

1. Statutory compliance to laws, regulations, and agency requirements
2. Data characteristics to assess which fundamental protections an application's data set requires
3. Privacy and confidentiality to protect against accidental and nefarious access to information
4. Integrity to ensure data is authorized, complete, and accurate
5. Data controls and access policies to determine where data can be stored and who can access physical locations
6. Governance to ensure that cloud computing service providers are sufficiently transparent, have adequate security and management controls, and provide the information necessary for the agency to appropriately and independently assess and monitor the efficacy of those controls

Conclusion

Conclusion

1. Cloud Computing is a great way to avoid the cost of implementing and managing infrastructure; what you run on that infrastructure and how successful the results will be depends on the skill and effort your team put into the work.
2. However: Cloud computing requires architecture, management and implementation. Start with architecture.
3. Most critical aspect of architecture analysis: the business operating model.
4. Establish current state, future state and transition plans
5. Define metrics for critical business performance areas, and ensure these are inherited by systems (SLAs)
6. Include cloud computing options as part of the future state technology alternatives for comparison
7. Ensure systems principles of technology architecture, dependability, and performance metrics are maintained through all alternatives, which often will require levels of diversification and redundancy to achieve

Given the significant benefits that cloud offers, mainstream adoption likely as vendor solutions mature and operating model challenges are overcome

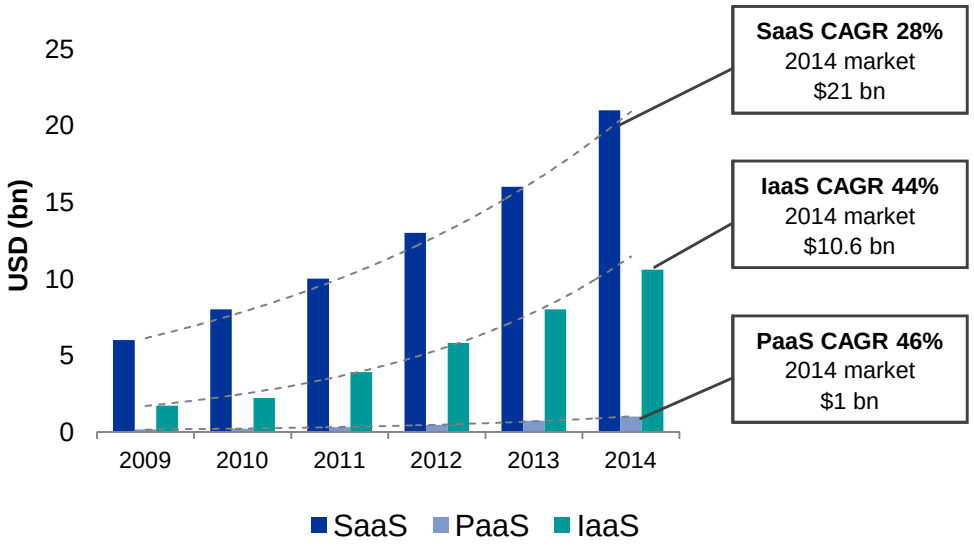
Finding Value Beyond The Hype

- The hype cycle for cloud is at all-time high and for good reason – the **benefits companies stand to gain from cloud are significant**: IT agility, decreased costs and improved IT service delivery capabilities to name but a few
- The **big question is how – not if**. Take-up statistics show that a large proportion of enterprises are beginning to leverage cloud to some extent or the other. **Wider scale adoption is primarily being held back due to organizations trying to understand how to overcome challenges** such as adopting new operating models, shaping appropriate data governance policies, addressing new security and risk controls, and understanding how to adjust tax strategies to the cross-border intricacies that cloud can bring

Long Term Outlook

- **The consensus on cloud growth remains polarized**: One positions cloud at the apex of the hype curve, but still two to five years away from mainstream adoption. The other suggests that cloud is about to "explode" over the next year
- In reality, **in the immediate term we are likely to see growth in segments** where offering dynamically scalable and virtualized resources makes good business sense (e.g., non-critical file storage or customer-facing applications that see large spikes in demand)

- The **strong benefits that cloud offers and the improved solution maturity and diversity** from vendors indicate that **it is here to stay**
- Moreover, many of the **operational and security challenges can be addressed through vendor management and enterprise architecture standardization**
- Within the five year time horizon, it is expected that **core cloud solutions will become mainstream services adopted widely by enterprise customers**
- **Bottom line:** Enterprises should **take the steps now to ensure they are well positioned to leverage cloud benefits in the future**; this includes ensuring that there is a **cloud strategy** in place, that **architecture** is being built **"cloud-ready"**, and that consideration has been given to **future operating model** implications



Gartner Cloud Market Growth Forecasts for SaaS, PaaS and IaaS

Sources: Deloitte – Cloud Computing: Finding Value Beyond The Hype; Deloitte – TMT Predictions 2010; Gartner - Hype Cycle for Cloud Computing 2010; Gartner – The Cloud-Computing Scenario 2010

Questions and Answers

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